CHAPTER 6

Foreign Systems

Most foreign wiring systems are not installed according to prescribed standards, so they do not conform to the rigid safety limitations and practices followed in the US. This fact may be attributed largely to material shortages in most foreign countries that have dictated the use and employment of materials at hand. In many instances, these materials would be considered below standard or expedient substitutes in the US. These limitations have been advantageous in some areas, such as the Scandinavian countries, because they have provided an incentive for electrical development that has resulted in more rapid advancement. This chapter acquaints electrical personnel with the major differences to be found and the precautions to be taken when making wiring installations or using equipment purchased or procured in a foreign country. To properly illustrate and discuss the major differences in foreign wiring, US standards are reviewed when necessary.

Section I. Wiring Installations

TYPE OF WIRING

The wiring system generally in use in most foreign countries is similar to open wiring installations because of the low material requirements. Other types of installations, outlined in the preceding chapters, are being installed in urban areas.

VOLTAGES

DOMESTIC

The US uses nominal voltages that range from 120 to 240 volts for single-phase AC low-voltage distribution. Though these voltages are considered to be standard voltage ratings because of their prevalent use, some locations and areas throughout this country still have DC systems or use AC systems with nonstandard voltages.

FOREIGN

Since many countries employ voltages other than those we accept as standard, the electrical equipment in use during occupancy or wartime must be converted, modified, or operated inefficiently when powered by foreign electrical installations. FM 5-422 includes frequency and voltage charts for different parts of the world.

FREQUENCY

The standard frequency of AC distribution in the US is 60 cycles. In most foreign lands, 50-cycle frequency generation is common, but US Army personnel could also encounter such frequencies as 25, 40, 42, and 100 cycles.

MATERIALS

BACKGROUND

The wiring materials commonly used in foreign countries are usually peculiar to the territory's manufacture. In recent years, however, the large export of electrical goods from Germany, England, and the US has been increasingly reflected in the established wiring patterns.

WIRE

The US employs the AWG system, which is peculiar to our installations. However, most foreign wire that Army personnel use differs in size and usage from those given in this manual. *Table B-23, page B-20,* gives the standard and metric diameter of standard AWG sizes.

DEVICES

The receptacles, switches, and plugs used in foreign wiring systems are also peculiar to the installations found in a particular area and normally cannot be mated or used with similar types of receptacles manufactured in the US.

Section II. Additions to Existing Installations

PROCEDURES

During occupancy or wartime in a foreign territory, the Army may commandeer and use all or part of a foreign electrical installation. Though the decision of employment is determined largely by the immediate circumstances, the Army electrician or unit commander will make this decision based on the availability of supplies and time.

SUPPLY

Since the electrical components of a foreign and domestic electrical system cannot be interchanged, the problem of supply is a major factor. The problems of installation and use of foreign power equipment should be compared to the necessary modification of US electrical items to meet the standards required in the foreign territory.

MODIFICATIONS

If time is a factor, consider using standard electrical items made in the US and modify the plugs or connections so that they may be used with the foreign installation. Though this method usually results in decreased operating efficiency, the ease of adaptability and abundance of supply usually outweigh the reduction in performance.

EFFECTS OF VOLTAGE DIFFERENCES

All equipment should be operated at its rated voltage. To expedite the use of a foreign system, items built to operate at standard US voltages may have to operate at different voltages. Though they may not be operated efficiently, their availability for use may be an important military advantage. Some effects of voltage differences on common electrical devices are—

- When fluorescent lamps are operated at voltages higher than standard, both the lamp and ballast life are shortened. Line voltages below the minimum of the

operating ranges of 110 to 240, 199 to 216, or 220 to 250 volts will cause uncertain starting, short lamp life, and reduced lighting efficiency.

- When incandescent lamps are used and operated at voltages higher than their normal ratings of 115, 120, and 125 volts, they have a shortened lamp life and their light output is increased. Conversely, if the line voltage of operation is below standard, the life of the lamps is increased and the lighting efficiency is reduced approximately 3 percent for each 1 percent drop in rated voltage.
- Rotating equipment, such as motors and fans, is usually manufactured to operate with a permissible voltage variation of 10 percent within their prescribed rating. The combined voltage and frequency variation is also limited to 10 percent. Higher voltages give increased torque, efficiency, and starting temperature. A lower operating voltage results in decreased torque, decreased efficiency, and increased running temperature. Operation at voltages differing from the rated voltage by more than 10 percent may be permitted only in an extreme emergency because the equipment could be damaged or destroyed by such operation.

EFFECTS OF FREQUENCY DIFFERENCES

Electrical operating items that are based on resistance characteristics such as heaters, hot plates, and electric stoves operate efficiently over all ranges of distribution frequencies used throughout the US and foreign territories. Rotating equipment and items such as lights and transmission or receiving equipment are adversely affected by variations in frequency. Some effects of frequency changes on this type of equipment are—

- Fluorescent lights rated to operate at nominal 60-cycle current can be used at 50 cycles, but they will have a shorter ballast life. At lower than 60-cycle frequencies, a noticeable flicker in the light output can be seen. This is undesirable in areas where painstaking and meticulous work is being performed. Operation at lower frequency is not satisfactory and should be avoided.
- Incandescent lights, because of their resistance design, will operate satisfactorily at all of the frequencies encountered overseas.
- Motors should not be connected to power-distribution systems with frequencies that vary more than 5 percent from their rated limits of operation. Some motors are built to function at either 50 or 60 cycles. Their shaft speed is directly proportional to the frequency of the power supply. Consequently, if a motor is nominally rated to run at 1,800 revolutions per minute at 60 cycles and is operated at 50 cycles, its output speed will be 1,500 revolutions per minute. Special motors with considerably larger frames must be obtained for the same power outputs at lower frequencies.
- All receiving and transmitting equipment or other items that have transformers included in their wiring will not operate satisfactorily either below or above their rated line frequency and should be used only in an emergency.

EFFECTS OF MATERIAL DIFFERENCES

Dissimilar metals should never be used together except in an emergency expedient installation. Interchangeable use of dissimilar materials in a power-distribution system can create problems. The close association of dissimilar metals can cause galvanic corrosion at the joints, which would eventually destroy the usefulness of the equipment. This is a particular concern when aluminum and copper are joined; however, new materials

that have no adverse effects are available specifically for connection to copper or aluminum. These new materials are marked for easy identification. If aluminum is used exclusively in a system, a special joint compound must be applied to all connections or joints. This compound protects the connection against excess surface oxidation because, unlike copper oxide, the oxide of an aluminum conductor adds a high contact resistance to the wire.